



Caribbean Tsunami Warning System

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Manager

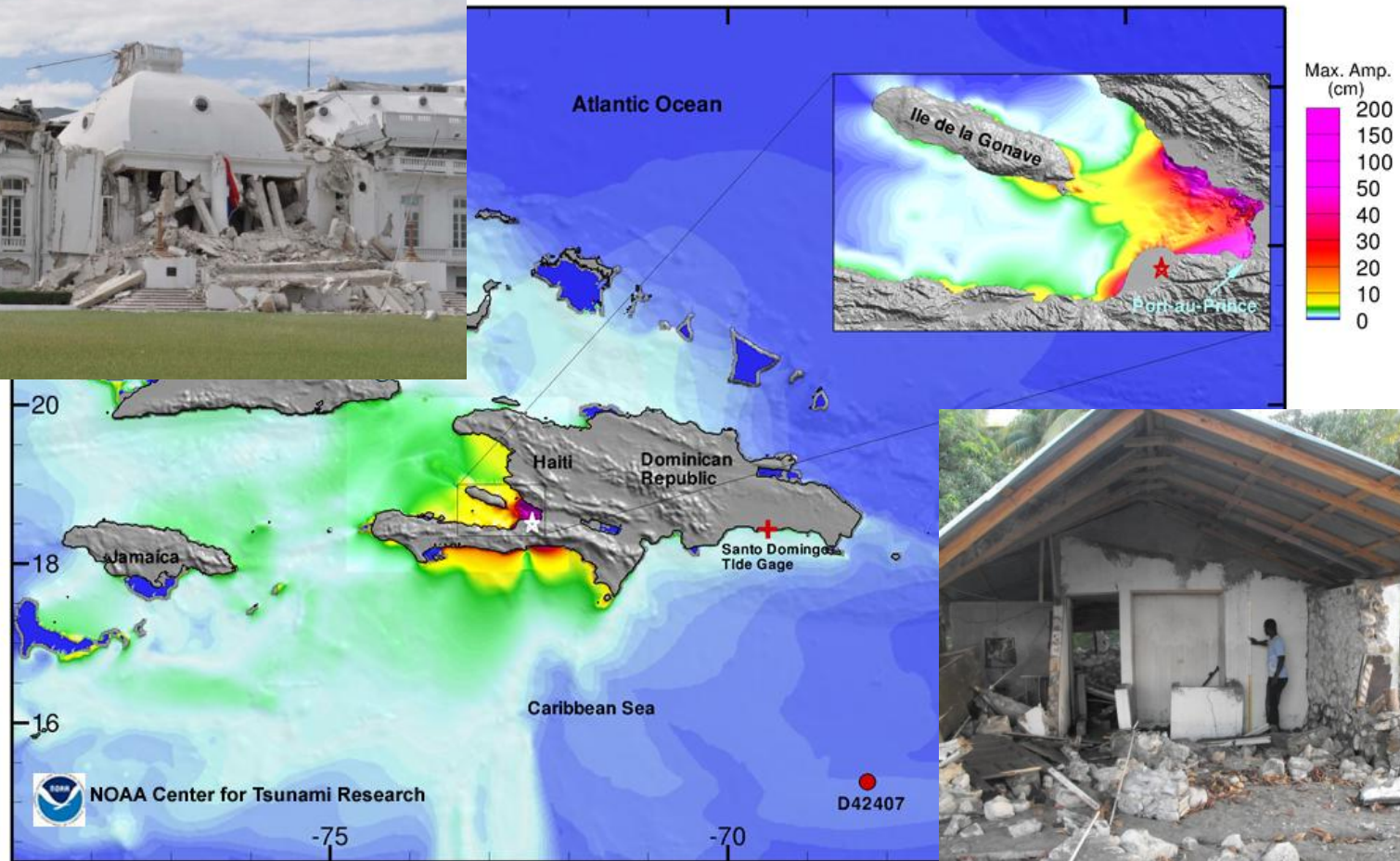
NOAA NWS Caribbean Tsunami Warning Program
Vice Chair UNESCO IOC CARIBE EWS
Researcher on Leave from the PRSN, Geology Dept., UPRM

Port Operators Workshop: The Tsunami Hazard
Mayagüez, Puerto Rico
2-3 November, 2010

Indeed the January 12, 2010 and the tragedy of our Haitian brothers and sisters was a grim reminder to us all that much more effort is needed to construct earthquake resilient societies, protecting lives, property and livelihood ...

Haiti Earthquake and Tsunami

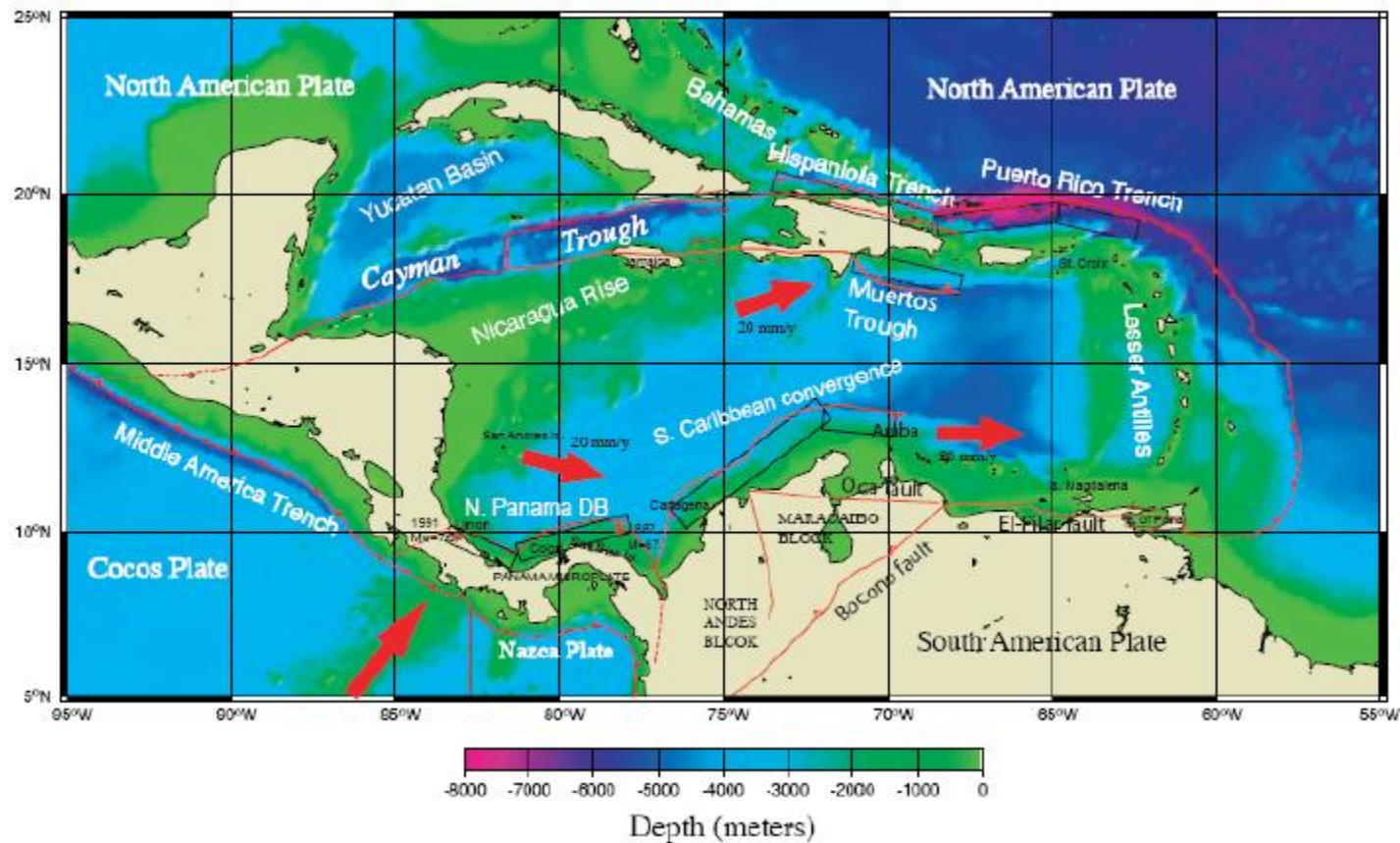
January 12, 2010, Mw 7.0, > 200,000 victims (EQ)



At least 7 people lost their lives from the tsunami.

Tsunami runup in Haiti

EQ Tsunami Sources in the Caribbean



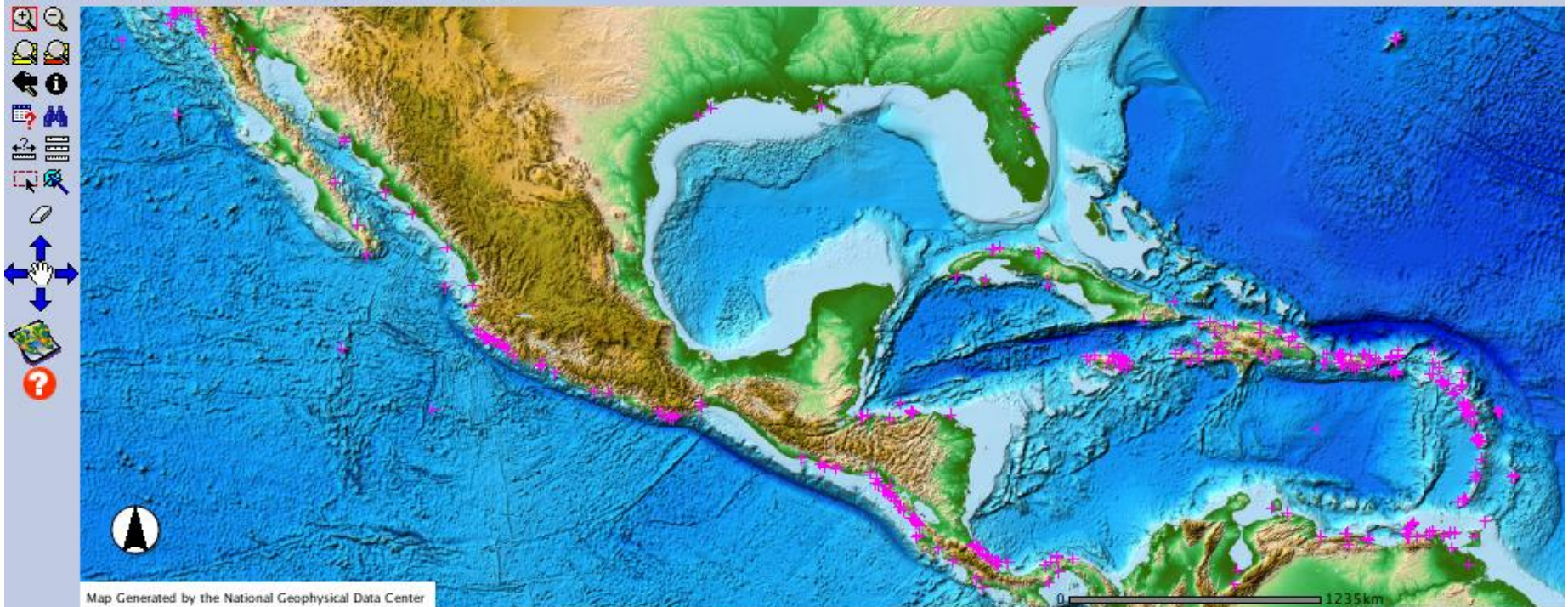
From ten Brink et al, 2008

Historical Tsunami Runups in the Caribbean



NOAA NATIONAL GEOPHYSICAL
DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA > NESDIS > NGDC > Marine Geology > Natural Hazards



40 definite tsunamis, 10 probable tsunamis, 33 questionable tsunamis,
14 very doubtful tsunamis and 1 seiche.

168 Years of Caribbean Tsunami



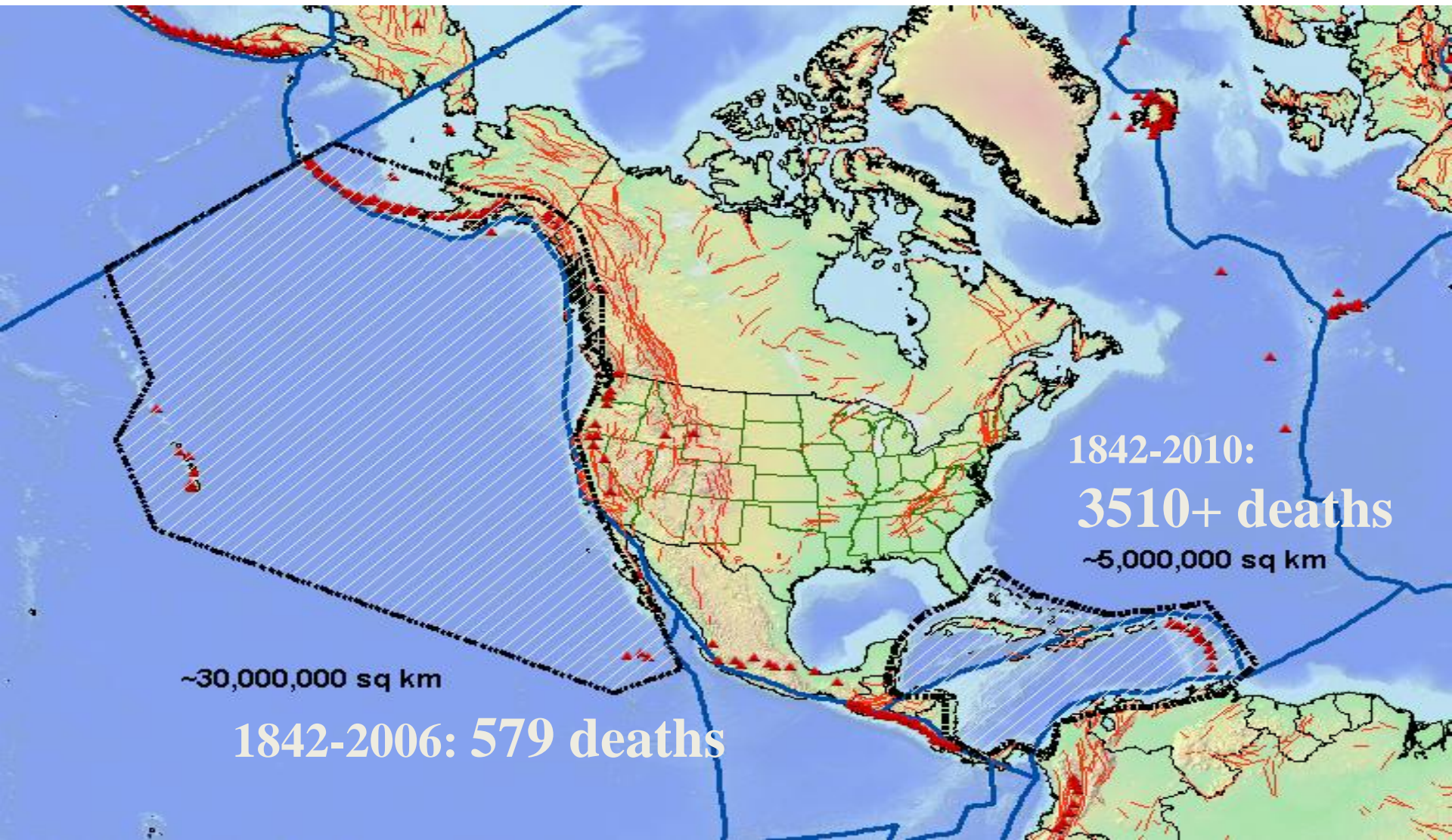
Deaths

Date	Place	Fatalities
1842	Haiti	300+
1853	Venezuela	600+
1867	Virgin Islands	23
1882	Panama	75+
1906	Jamaica	500
1918	Puerto Rico	140
1946	Dominican Republic(1)	1790
1946	Dominican Republic(2)	75
2010	Haiti	7
TOTAL		3510

Ref: *Caribbean Tsunamis, A 500-Year History from 1498-1998* by Karen Fay O'Loughlin and James F. Lander (2003: ISBN 1-4020-1717-0); Tsunamis of the Eastern US, NGDC, 2002 Science of Tsunami Hazards, vol 20, #3, pg 120; PRSN on Haiti, 2010

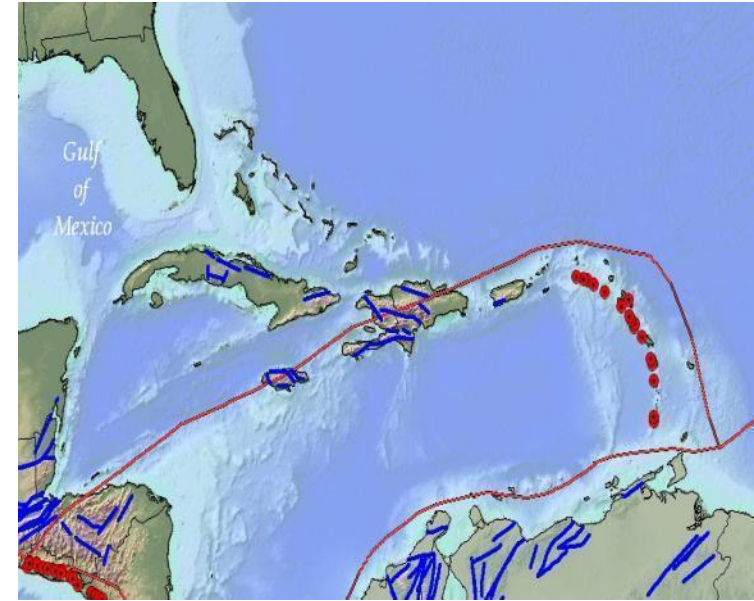
Since 1842, at least 3510 people have lost their lives to tsunamis, this is more than in the Northeastern Pacific...

The Caribbean basin in only 1/5 the area had nearly 6x more deaths !



The Caribbean Situation

- Last major tsunami event(s):
Dominican Republic: $1790 + 75 = 1865^*$ deaths in August, 1946.
- Since 1946, explosive population growth across Caribbean from residents and tourists at the coasts
- Therefore, the Caribbean's historical deaths from tsunamis greatly understates its current 21st century potential loss of life!
- If we just take into consideration the number of people that can be on the beach, 50,000 people are exposed daily to tsunamis in the region.

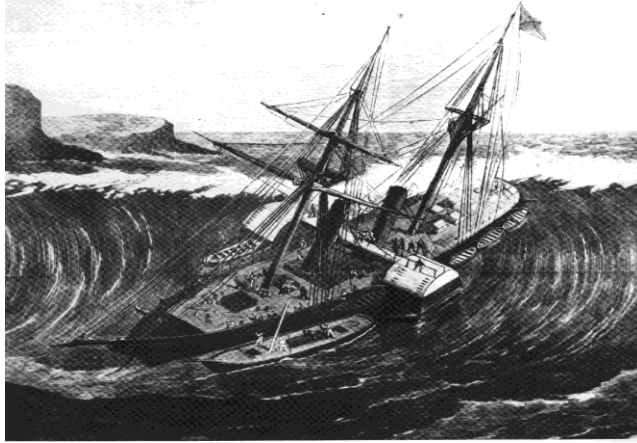


The Basin has many tsunami-genic areas: tectonic zones & faults, shelves-trenches, volcanoes

*Statistics from *Caribbean Tsunamis, A 500-Year History from 1498-1998*
by Karen Fay O'Loughlin and James F. Lander
(ISBN 1-4020-1717-0 2003 edition)

The risk to life from tsunamis has increased dramatically due to coastal population and tourism growth.

Here we see the port at Charlotte Amalie Bay, St. Thomas

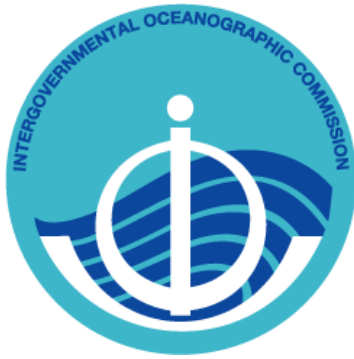


20 Foot tsunami, November 18, 1867

Same bay in St. Thomas today with 25,000 lives at risk !



30 people lost their lives on November 18, 1867 in a 20 ft tsunami. Today there can upwards of 15,000 to 25,000 people at risk because of cruise ships. Almost all these people are in the tsunami inundation zone around the bay, beaches and shops.



The regional response...

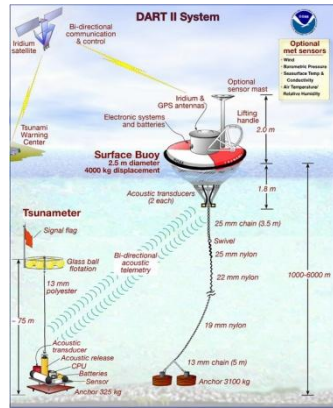
UNESCO IOC Intergovernmental
Coordination Group for Tsunamis and
Other Coastal Hazards Warning System
for the Caribbean and Adjacent Regions

Main Components of CARIBE EWS

Per recommendation of the Member States

- Working Groups:
 - Monitoring and Tsunami Warning Guidance
 - Tsunami Hazard, Risk and Vulnerability Assessments
 - Communications
 - Preparedness, Readiness and Resilience
- Permanent Bodies
 - Caribbean Tsunami Warning Center-CTWP potential first step
 - Caribbean Tsunami Information Center – to be established in Barbados with funding by the Govt. of Italy
 - Secretariat-Interim location in Paris, France at UNESCO HQ
- **National Stakeholders**
 - **National Tsunami Contacts**
 - **Tsunami Warning Focal Points**

Tsunami Warning System



Observational Data

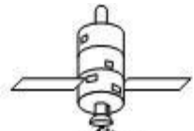


Seismometer

Tide Gage



Pressure Sensor



Warning Bulletins



Tsunami Warning Center

NWS Gateway

State EOC

US Coast Guard

EMWIN, GTS, Media/FOS, Military, etc.

Weather Forecast Office

Local EOC



NOAA Weather Radio



Emergency Alert System

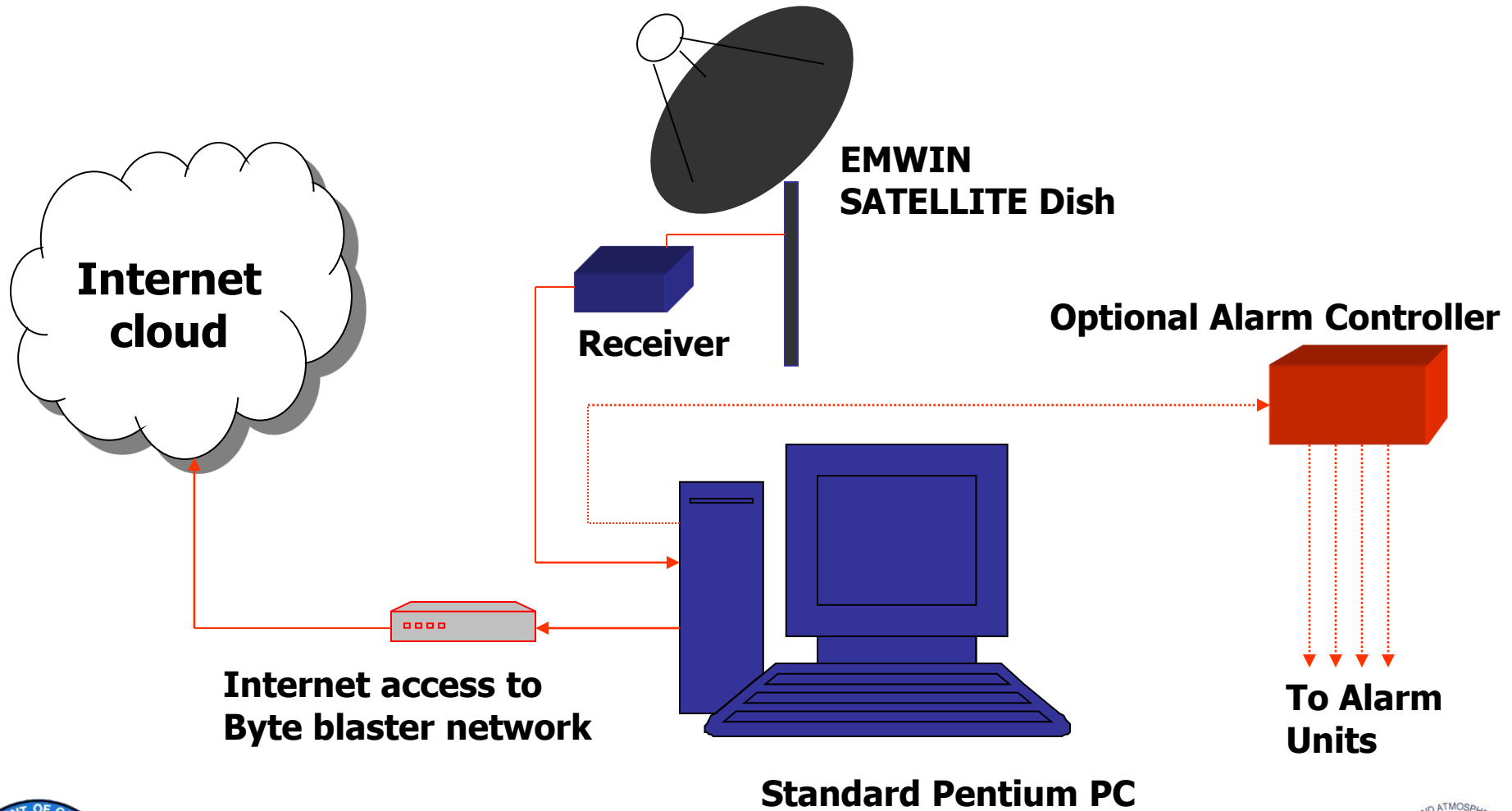


Sirens, etc.

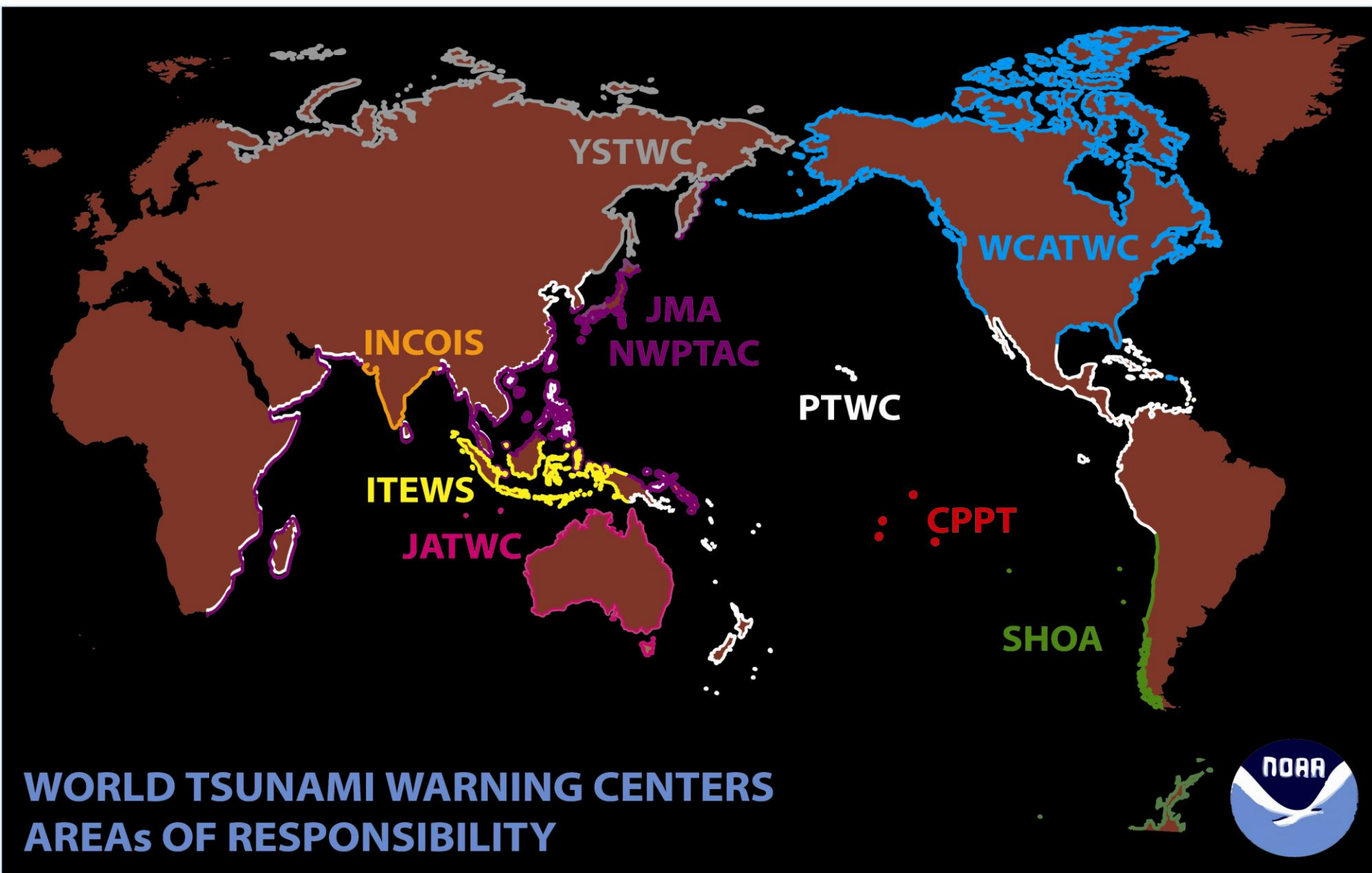


Mariners

EMWIN System

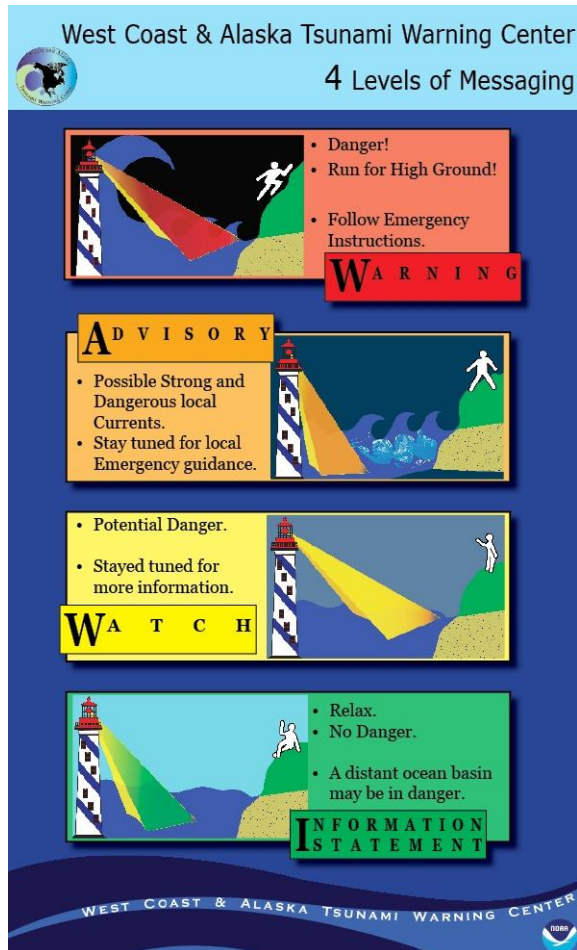


YSTWC - Yuzhno-Sakhalinsk Tsunami Warning Center
 INCOIS - Indian National Centre for Ocean Information Services
 ITEWS - Indonesia Tsunami Early Warning System
 JATWC - Joint Australia Tsunami Warning Centre
 WCATWC - West Coast and Alaska Tsunami Warning Center
 JMA NWPTAC - Japan Meteorological Agency
 North West Pacific Tsunami Alert Center
 PTWC - Pacific Tsunami Warning Center
 CPPT - Centre Polynésien de Prévention des Tsunamis
 SHOA - Servicio Hidrográfico y Oceanográfico de la Armada



Caribbean Tsunami Messages

US Caribbean



PTWC Non US Caribbean

Caribbean Sea Wide Watch

Regional Watch

Local Watch

Information Statement

Cancellation

WECA41 PHEB 231802
TSUCAX

TSUNAMI MESSAGE NUMBER 6
NWS PACIFIC TSUNAMI WARNING CENTER/NOAA/NWS
ISSUED AT 1802Z 23 MAR 2011

THIS MESSAGE IS FOR ALL AREAS OF THE CARIBBEAN EXCEPT
PUERTO RICO AND THE VIRGIN ISLANDS. THE WEST COAST/
ALASKA TSUNAMI WARNING CENTER WILL ISSUE PRODUCTS FOR
THESE AREAS.

... THE TSUNAMI WATCH IS CANCELLED ...

THIS BULLETIN IS ISSUED AS ADVICE TO GOVERNMENT AGENCIES. ONLY
NATIONAL AND LOCAL GOVERNMENT AGENCIES HAVE THE AUTHORITY TO MAKE
DECISIONS REGARDING THE OFFICIAL STATE OF ALERT IN THEIR AREA AND
ANY ACTIONS TO BE TAKEN IN RESPONSE

PRELIMINARY EARTHQUAKE PARAMETERS

MAGNITUDE - 7.6
TIME - 1300 UTC MAR 23 2011
LOCATION - 18.2 NORTH 65.3 WEST
25 MILES/40 KM SE OF FAJARDO PUERTO RICO
55 MILES/89 KM SE OF SAN JUAN PUERTO RICO
DEPTH - 56 MILES/90 KM

500 PEOPLE HAVE BEEN REPORTED DEAD DUE TO THIS EVENT AND
NUMEROUS REPORTED MISSING. DAMAGE CAUSED BY THE FIRE IN LIMETREE
BAY, VI AND THE TSUNAMI'S INUNDATION IN THE CARIBBEAN IS ESTIMATED
TO BE MORE THAN \$350M USD THUS FAR. THE FIRE AND OIL SLICK AT
LIMETREE BAY VI HAS BEEN CONTAINED BUT INLAND FIRES WEST OF
LIMETREE BAY CONTINUE TO BE FAUGHT. STRONG CURRENTS ARE ONGOING
IN HARBORS THROUGHOUT THE EASTERN CARIBBEAN REGION.
SIGNIFICANT FLOODING HAS CEASED HOWEVER DANGER IN THE
WATER PERSISTS. FOOD AND PERSONNEL AID IS CURRENTLY BEING
FLOWN FROM NAS KEY WEST TO SEVERAL COMMUNITIES THROUGHOUT THE
CARIBBEAN.

EVALUATION

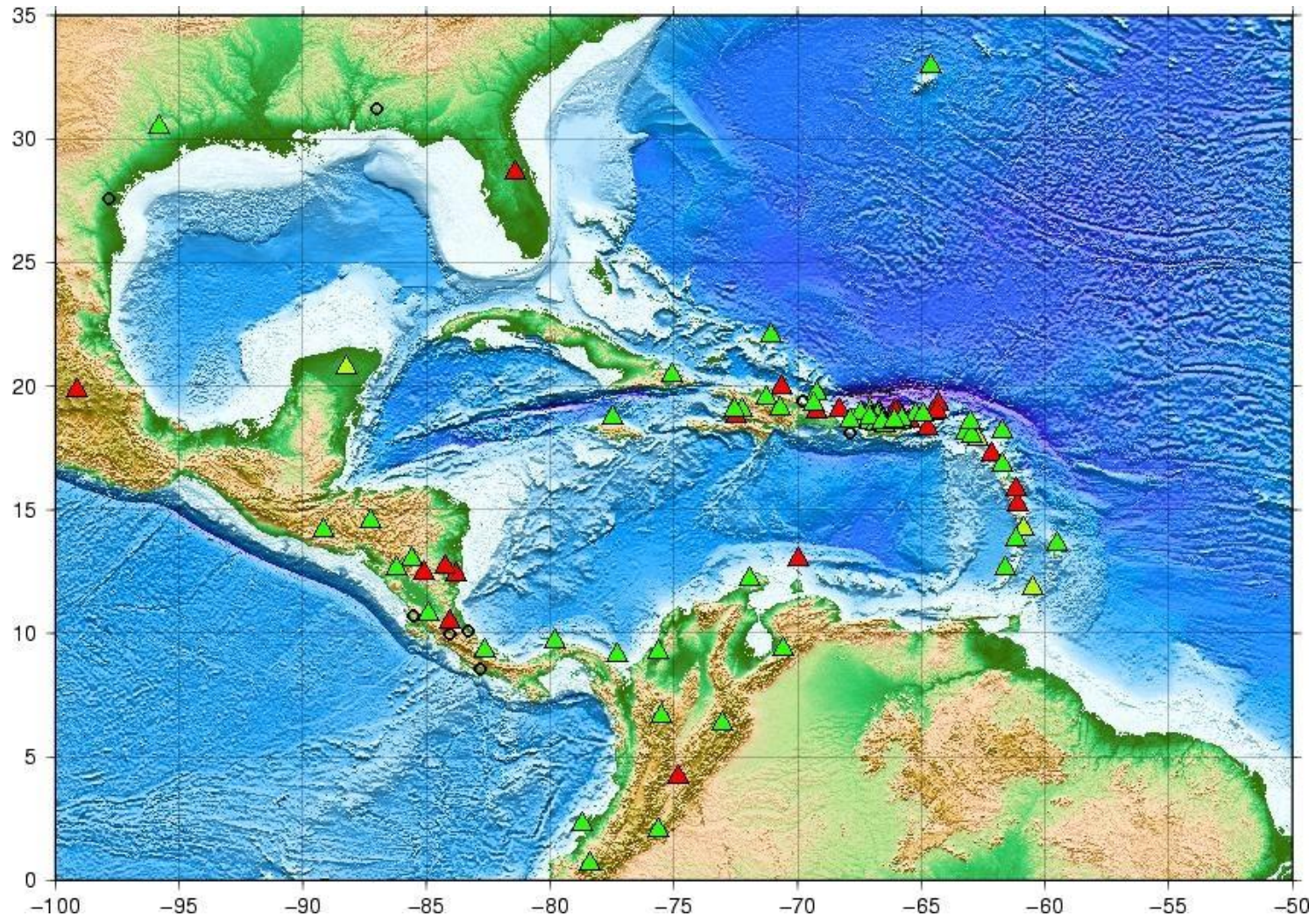
A DAMAGING TSUNAMI WAS OBSERVED IN THE NE CARIBBEAN SEA. MANY
REPORTS OF DAMAGE HAVE BEEN RECEIVED BY THE CENTER. SEA LEVEL
GAGES AND FORECAST MODELS INDICATE THAT THREAT LEVELS IN AFFECTED
REGIONS SHOULD NOW AT LOW LEVELS.

FOR ANY AFFECTED AREAS - WHEN NO MAJOR WAVES HAVE OCCURRED FOR AT
LEAST TWO HOURS AFTER THE ESTIMATED ARRIVAL TIME OR DAMAGING WAVES
HAVE NOT OCCURRED FOR AT LEAST TWO HOURS THEN LOCAL AUTHORITIES
CAN ASSUME THE THREAT IS PASSED. DANGER TO BOATS AND COASTAL
STRUCTURES CAN CONTINUE FOR SEVERAL HOURS DUE TO RAPID CURRENTS.
AS LOCAL CONDITIONS CAN CAUSE A WIDE VARIATION IN TSUNAMI WAVE
ACTION THE ALL CLEAR DETERMINATION MUST BE MADE BY LOCAL
AUTHORITIES.

THIS WILL BE THE FINAL BULLETIN ISSUED BY THE PACIFIC TSUNAMI
WARNING CENTER FOR THIS EVENT UNLESS ADDITIONAL INFORMATION
BECOMES AVAILABLE.

Seismic Data Availability in the Caribbean

77% (95/124) of Core CARIBE EWS Stations are contributing in real time



<http://redsismica.uprm.edu/Spanish/>

Sea Level Data Availability in the Caribbean

100% (6/6) of the DART stations are installed

20% (19/94) of coastal sea level gauges are operational and transmitting at least every 15 minutes

[IOC Sea Level Facility](#)



SEA LEVEL STATION MONITORING FACILITY

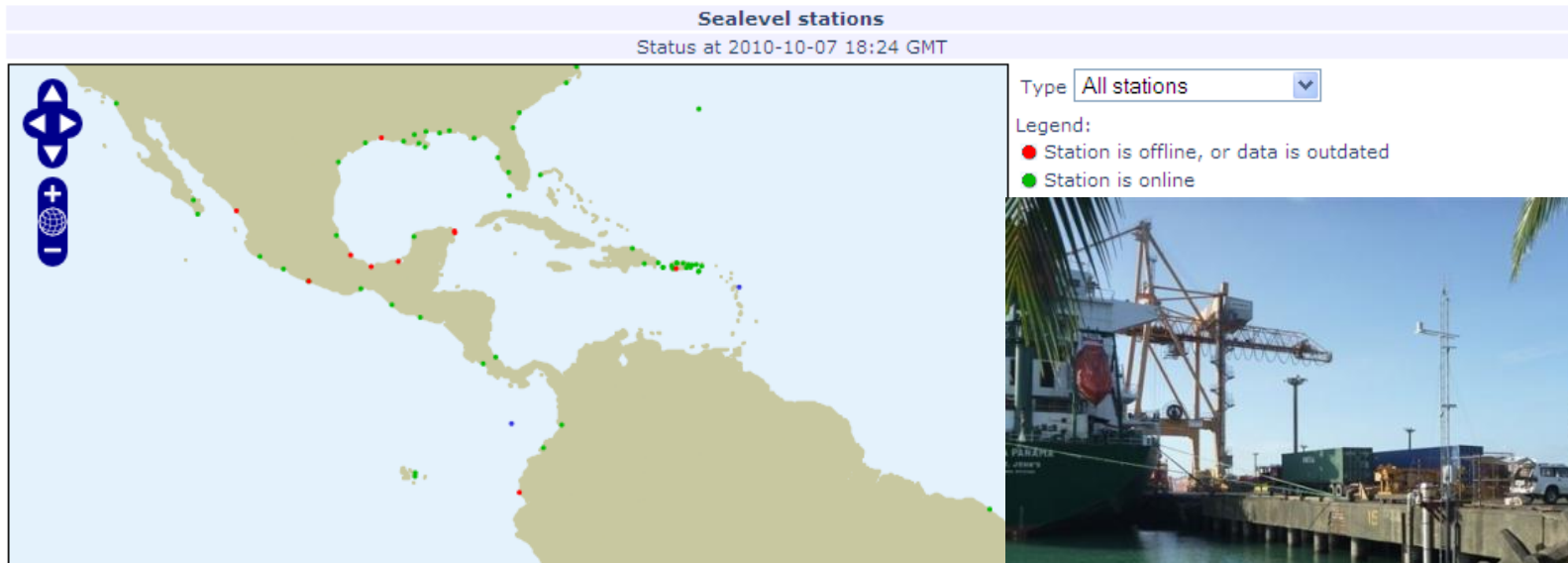
Intro

Map

Stations

Database

Metadata

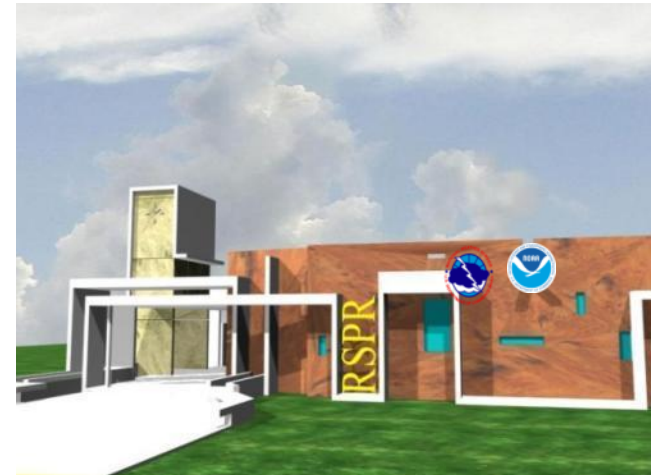


Limón, Costa Rica sea level station,
upgraded in 2009 w/ USG funding

CTWC

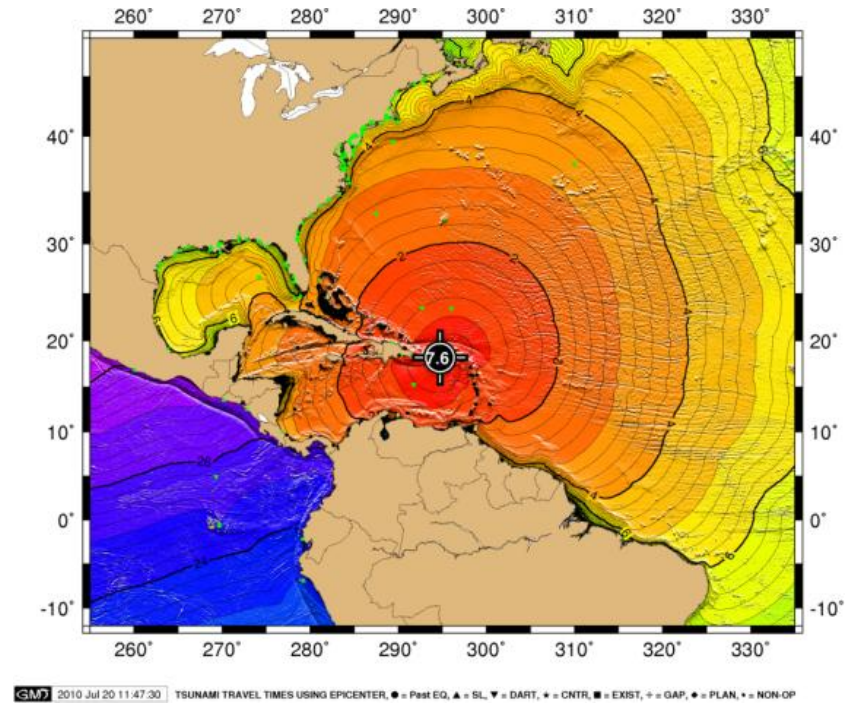
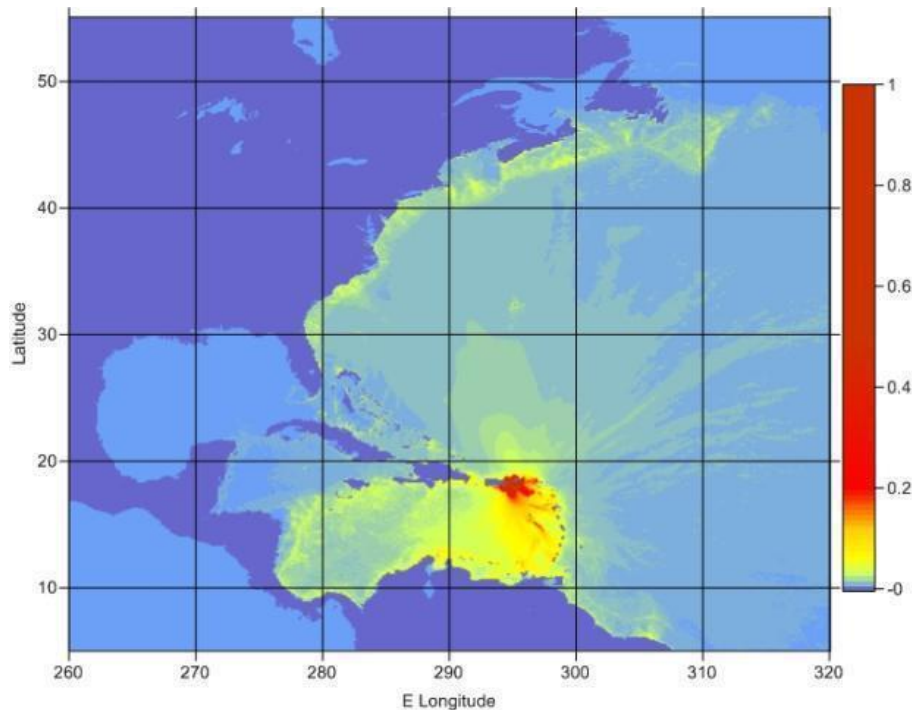
“Providing regional service, strengthening local capabilities...”

- NOAA NWS established in February 1, 2010 the **Caribbean Tsunami Warning Program**, jointly located at the Puerto Rico Seismic Network at the University of Puerto Rico at Mayagüez as a 1st step of the U.S. towards the establishment of a Caribbean Tsunami Warning Centre.
- When will the Program become a Centre?
 - Funds are appropriated
 - Upon CARIBE EWS recommendation
- ICG VI will consider further contributions of MS to the establishment of a Regional Tsunami Warning Center



CARIBE WAVE LANTEX 2011, March 23, 2011

- Tsunami generated by a magnitude 7.6 earthquake in the US Virgin Island Basin (similar to the 1867 VI EQ and Tsunami)



Time Table for CaribeWave 2011

Date (UTC)	Time (UTC)	WCATWC Message				PTWC Message			
		#	Type	Dummy	Email	#	Type	Dummy	Email
03/23/2011	1300		----- Earthquake Occurs -----						
03/23/2011	1302	01	Warn	Yes	Yes	01	Watch	Yes	Yes
03/23/2011	1332	02	Warn	No	Yes				
03/23/2011	1401	03	Warn	No	Yes	02	Watch	No	Yes
03/23/2011	1431	04	Warn	No	Yes				
03/23/2011	1500	05	Warn	No	Yes	03	Watch	No	Yes
03/23/2011	1530	06	Warn	No	Yes				
03/23/2011	1601	07	Adv	No	Yes	04	Watch	No	Yes
03/23/2011	1630	08	Adv	No	Yes				
03/23/2011	1701	09	Can	No	Yes	05	Watch	No	Yes
03/23/2011	1802					06	Can	No	Yes

Location	Travel time (hr:min)	Max Amp. (meters)	Leading Edge
Charlotte Amalie, VI	0:01	2.7	elevation
Christiansted, VI	0:01	2.5	recession
San Juan, PR	0:12	0.59	elevation
Mayaguez, PR	0:47	0.50	recession
Santo Domingo	1:02	0.18	
Bridgetown, Barbados	1:38	0.05	recession
Port Au Prince, Haiti	3:57	0.04	recession

Working together to save lives, property and livelihood...



Thank you

christa.vonh@noaa.gov

More information...

- NOAA NWS <http://tsunami.gov>
 - Caribbean Tsunami Warning Program, Tel. 787-833-8433, christa.vonh@noaa.gov
- Puerto Rico Seismic Network
 - <http://prsn.uprm.edu>
- PRTWMP with PR Tsunami Inundation Maps
 - <http://poseidon.uprm.edu>
- UNESCO IOC Caribe EWS <http://www.ioc-tsunami.org/>



Welcome

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RECENT SIGNIFICANT EARTHQUAKES

Magnitude	Agency	Local Time (GMT-4)	Latitude	Longitude	Depth	Region
3.3M	PRSN	2010-07-14 08:34:05	18.022	-65.327	8	EASTERN DOMINICAN REPUBLIC
3.61M	PRSN	2010-07-13 19:45:22	18.409	-68.434	161	EASTERN DOMINICAN REPUBLIC
3.57M	PRSN	2010-07-12 05:10:02	19.565	-66.420	43	PUERTO RICO TRENCH
4.63M	PRSN	2010-07-07 11:05:41	19.044	-64.759	4.75	SOMBRERO SEISMIC ZONE
3.51M	PRSN	2010-07-05 01:28:39	18.516	-68.827	109.9	EASTERN DOMINICAN REPUBLIC
4.6M	PRSN	2010-07-02 09:44:47	18.645	-68.731	179.9	SOMBRERO SEISMIC ZONE
3.36M	PRSN	2010-07-01 16:42:30	19.079	-64.884	112	PUERTO RICO TRENCH
3.68M	PRSN	2010-06-19 08:35:49	19.560	-65.385	96.7	EASTERN DOMINICAN REPUBLIC
3.69M	PRSN	2010-06-17 20:44:59	18.451	-68.884	125.0	SOMBRERO SEISMIC ZONE
3.68M	PRSN	2010-06-15 15:23:08	19.100	-64.797	89	PUERTO RICO TRENCH
4.53M	PRSN	2010-06-15 15:05:33	19.553	-65.439	40	PUERTO RICO TRENCH

Special Reports

Monthly Reports
Detailed information of the monthly seismicity in Puerto Rico and Virgin Islands

Annual Reports
Annual Reports of the seismic activity

Haiti Earthquake
Special Report about the earthquake occurred in Haiti on January 12, 2010

CAPECO Explosion
Explosion of the Caribbean Petroleum refinery at Bayamón, October 23

Seismicity in North Area
Special Report of the seismic activity detected in the north area of Puerto Rico

Earthquakes

Felt Earthquakes
List of felt earthquakes in Puerto Rico or Virgin Islands

Significant Earthquakes
List of earthquakes with a magnitude of 3.5 or greater, or reported as felt

Caribbean and adjacent regions
Earthquakes detected by the Puerto Rico Seismic Network (PRSN) in Caribbean and adjacent regions with a magnitude of 4.5 or greater

Seismograms
View seismograms for all seismic stations

Online

Report a felt earthquake
If you have felt an earthquake in PR, you can help us to determine the intensity of the same one by completing our electronic form.

Educational Portal of Emergency Management
Interactive courses that provide training and preparedness for natural phenomenon.

Conference Request
To apply for conferences, lectures, workshops or arrange a visit to the Seismic Network.

Subscribe to our mailing lists
To receive information about seismic events directly to your email.

News and activities

Preventive measures to minimize the effects of an earthquake
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Press Releases
[Know more...](#)

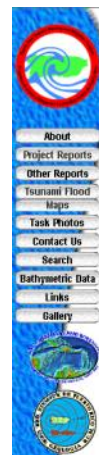
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Calendar of Activities
[Details...](#)

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Courses, Workshops and Conferences
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UNITEX 2011: A tsunami warning exercise for U.S. east coast, the Gulf of Mexico and the Caribbean
[Participate...](#)



February 9, 2007

CARIBBEAN TSUNAMI HAZARD

Proceedings of the NSF Caribbean Tsunami Workshop
San Juan, Beach Hotel, Puerto Rico 30 - 31 March 2004

edited by Aurelio Mercado-Irizarry (University of Puerto Rico, USA) & Philip Liu (Cornell University, USA)

This book aims to present the overall existing tsunami hazard in the Caribbean Sea region, a region which is typically only associated with hurricanes. It initially presents an overview of all of the existing tsunami-causing factors found in the region: earthquakes, sub-aerial and submarine landslides, and submarine explosions. This is followed by field evidence of recent and pre-historic tsunami events, which gives credibility to all of this effort. The next section is a description of the tsunami hazard mitigation efforts being carried out locally and in collaboration with national and international programs. The final part is dedicated to the presentation of related recent research results.

August 28, 2000

TSUNAMI THE FORGOTTEN DANGER

VIDEO DOCUMENTARY

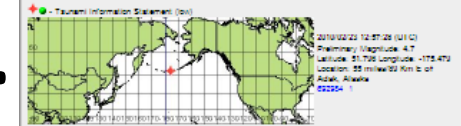
NEW DVD VERSION AVAILABLE FOR DOWNLOAD!

The tsunami documentary produced in Puerto Rico. This video includes the history, hazards, and protective measures concerning tsunamis. The video was prepared by JAM Media (San Juan, P.R.) and it has been freely distributed to many schools, governmental and private agencies. To obtain copies of the documentary (VHS or DVD) contact the Puerto Rico Seismic Network Teléfonos: 787-833-8433, 787-265-5452.

Three DVD quality versions available for download. On IE right button click on image and select 'Save Target As...'. Warning: This are very large files! Broadband (DSL or Cable Internet) recommended. If you're on dial-up use a download manager.

West Coast and Alaska Tsunami Warning Center

Latest Event



Please click [here](#) to see the area-of-responsibility (AoR) for the WC/ATWC and the PTWC.

The NWS operates two Tsunami Warning Centers and the International Tsunami Information Center

West Coast/ Alaska Tsunami Warning Center (WC/ATWC)

The WC/ATWC provides tsunami warning guidance for all U.S. coastal states (except Hawaii), the Canadian coastal provinces, Puerto Rico, and the Virgin Islands.

Richard H. Hagemeyer Pacific Tsunami Warning Center (PTWC)

The PTWC provides tsunami warning guidance for Hawaii and countries in the Pacific Ocean, Indian Ocean, and Caribbean Sea.

International Tsunami Information Center (ITIC)

Operated by the NWS on behalf of the Intergovernmental Oceanographic Commission of UNESCO, the ITIC supports the IOC's Tsunami Program which focuses on the coordination of tsunami warning and mitigation systems globally. The ITIC provides direct support to Member States in the Pacific by monitoring and recommending operational improvements to the Tsunami Warning System in the Pacific and by working with countries to increase tsunami awareness and preparedness, and promote education and research.

Is your community prepared for the next destructive tsunami?

TsunamiReady Program

A program designed for recognition for Communities that have met certain standards of tsunami preparedness.

United Nations Educational, Scientific and Cultural Organization

IOC Tsunami Information

Welcome

The IOC of UNESCO was established in 1960 and has successfully coordinated the Pacific Tsunami Warning System (PTWS) for the Pacific since 1965. After the Sumatra tsunami on December 26, 2004, the IOC received the mandate to help all UNESCO Member States of the Indian Ocean rim to establish their own Tsunami Early Warning System (TEWS).

At the same time IOC began coordinating the establishment of similar Early Warning Systems (EWS) for tsunamis and other ocean-related hazards in the Caribbean (CARIBE-EWS) and the Mediterranean and Northeast Atlantic Ocean and connected seas (MEDATWS).

To provide immediate interim coverage for tsunami warnings in all other oceans, advisory systems have been established under the sign of the IOC of UNESCO, in cooperation with the Pacific Tsunami Warning Center (PTWC) from the USA and the Japan Meteorological Agency (JMA) from Japan.

Tsunami Warning Systems (TWSs), owned and operated by Member States, collect, distribute and interpret continuously all available seismic and sea level data for the existence and propagation of a tsunami. They issue timely and clear warnings for their area of operation and exchange these data and information with other national and international centres. Complementary and sustained activities in tsunami hazard risk assessment, tsunami warning training, emergency response, and preparedness are part of the comprehensive tsunami mitigation programs that extend the TWS's as end-to-end systems.